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## Diversity- and Innovation Management in Complex Engineering Organizations

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## **Diversity- and Innovation Management in Complex Engineering Organizations**

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### **Abstract**

*Diversity is increasingly being addressed as an innovation-promoting factor. For this reason, companies and institutions tackle the integration of a diversity management approach that enables a heterogenic perspective on innovation development. However, system-theoretical frameworks state that the implementation of diversity measures that are not tailored to the needs of the organization often leads to a rejection or reactivity with regard to the management approach. In this context, especially organizations, which are characterized by a specific hierarchical structure, a dominant habitus or specialist culture, must face the challenge of realizing a sustainable change of the corporate culture that sets the basis for implementing diversity management approaches. The presented research project focuses on analyzing the situation in a huge scientific collaborative project - so called Cluster of Excellence (CoE) - with the aim to implement a diversity - and innovation management strategy. Considering the influencing determinants, the CoE is characterized by its embeddedness in the scientific system, a complex organizational structure, and a high fluctuation rate. The paper presents a systemic approach of reflecting these factors in order to develop a diversity- and innovation management strategy. In this frame, the results of a quantitative survey of CoE employees and derived mindset-types are presented. The results show a need for taking different mindset-types into account, to be able to develop a tailored management strategy. The aim of the project is to give recommendations for developing a sustainable management concept that promotes both diversity and innovation by drawing on the persisting mindsets of organization members while reflecting top down as well as bottom up factors of implementation processes as well as the psychology of change. This paper addresses all who are concerned with the management of human resources in innovation processes and are striving for a cultural change within the framework of complex organizations.*

**Keywords:** Change Management, Corporate Culture, Diversity Management, Engineering, Innovation Management

Track: Management & Leadership

Word count: 9.415

### **1. Introduction**

Implementing a diverse workforce in organizations has become a popular topic across all major industries (Forbes, 2012). Originally originating in the private sector, the approach of diversity management has been implemented in German companies since the turn of the millennium (Bissels, Sackmann and Bissels, 2000). Therefore, the implementation of the approach is carried out with differing motivations. Often, the argumentation of motivation centers around the potential profits resulting from the successful implementation of diversity management. Especially in the frame of research and development processes different companies and industries “[...] take for granted the idea that diversity pays dividend in innovation problem solving.” (Smith-Doerr, Alegria and Sacco, 2017). This assumption was

followed by various research projects, which, with the help of different approaches, examined the innovation potential of different categories of diversity.

The paper will give, an overview of studies that deal with the context between diversity and innovation. Building on that, the connection between diversity management and change management is described, setting the basis for a system theoretical diversity management approach (chapter 2). Chapter three then describes the approach of investigating prevailing mindsets and attitudes linked to the diversity categories 'gender' and 'origin'. The study has been realized in a research organization in Germany that is strongly shaped by an engineering science habit. In order to clarify the approach, the methodology will be explained afterwards (chapter 4). In this framework, the particularities and challenges of the CoE as research object will be a subject of discussion. After that, results are presented (chapter 5). Chapter 6 concludes with a discussion of the results, the reflection of limitations and an outlook on future research.

## 2. Theoretical Background

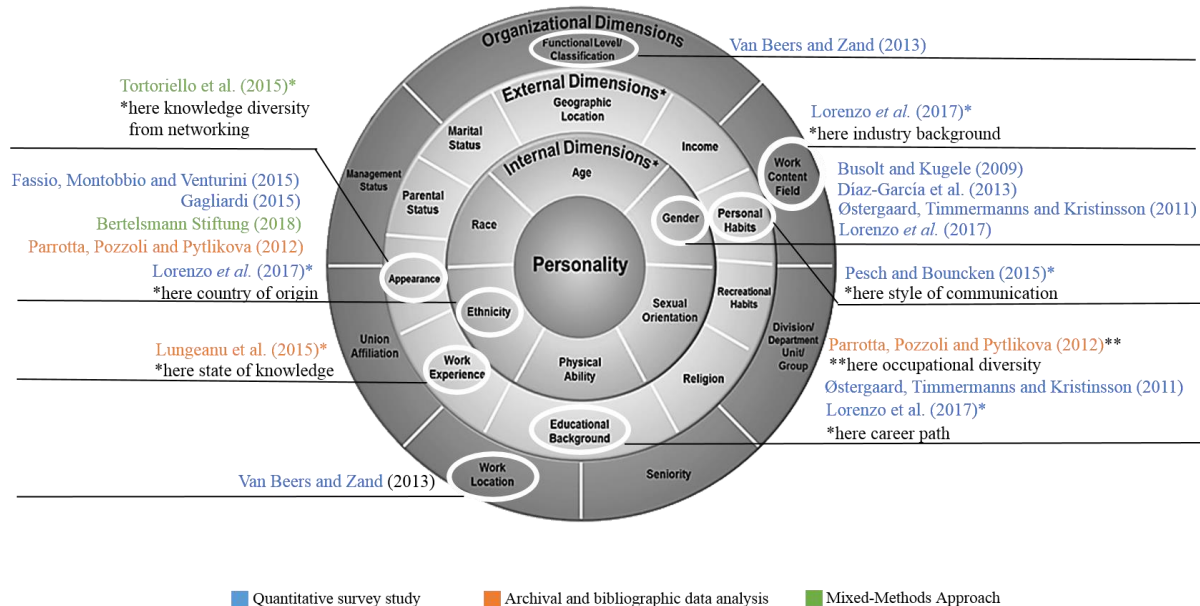
Lorenzo *et al.* (2017) investigated within the framework of a study with 171 companies from Germany, Switzerland and Austria, the positive correlation of country of origin, career path, background and gender in the context of innovation. In particular, they identified relationships between the size and complexity of the organization in the context of diversity management. The larger and/or more complex a company is, the more it benefits from diversity in management. For small or less complex companies, however, the influence tends to be smaller or even non-existent. With regard to specific diversity categories, Lorenzo *et al.* (2017) determine that the increase of gender diversity only has a positive effect if more than 20% of women work in management positions. Based on this result, they conclude that a high proportion of women among employees alone is not enough to increase innovation. Rather, an active diversity management is required, which makes it possible that "[...] gender diversity [...] go[es] beyond tokenism." (Lorenzo *et al.*, 2017, p. 4). Lungeanu and Contractor (2015) examined the influence of different types of diversity, both observable and not observable diversity categories (Milliken and Martins, 1996; Loden and Rosener, 1991; Watrinet, 2008), on the creation process of innovation ideas. In the frame of their study, they focused on the influence of the diversity categories gender, cognitive and country diversity on the formation process of scientific collaborative innovation networks. The study with 1,354 researchers was mainly based on 469 publications, which were used to assess the degree of collaboration and networking. Their results show ambivalent results. Innovations, operationalized in the frame of publications, benefit from diversity but also from homophily. With regard to the advantages of homophily they argue, that homogeneous cultural backgrounds, operationalized through country of residence, as well as working with existing networks leads to a reduction of uncertainty. In contrast to this, diversity allows the inclusion of diverse perspectives as well as knowledge and thus, "[...] enables the recombinant knowledge required for innovation." (Lungeanu and Contractor, 2015, p. 548). Finally they conclude: "[...] that innovation, exemplified as publishing in a new scientific discipline, benefits from both homophily and diversity." (Lungeanu and Contractor, 2015, p. 560). With regard to the chances and challenges of diversity in research and development processes, Díaz-García, González-Moreno and Sáez-Martínez (2013) also come to an ambivalent conclusion in the frame of their analysis. From their point of view, employee diversity can lead to misunderstandings and conflicts based on the heterogeneous perspectives and mindsets. In this context, Voigt and Wagner (2006) define coordination and conflict losses through heterogeneity in the sense of the 'process hypothesis', which means fundamental process losses through diversity. Also Pelled, Eisenhardt and Xin (1999) suggest that different

forms of diversity can cause different forms of conflicts. According to that, Østergaard, Timmermans and Kristinsson (2011) notice a difference in the benefits of diversity in the frame of individual categories of diversity. While educational and gender diversity could lead to innovation, age diversity does not. Pesch, Bouncken and Kraus (2015) focus in the frame of their analysis on communication styles in context with innovation. The analysis, based on a survey study of 232 German small and medium-sized enterprises (SMEs), indicates ambivalent effects of diverse communication styles. Their results show, that on the one hand diversity in communication style enhances a creative team environment and thus contributes to innovation. In this context, innovation is considered in the frame of product innovativeness and market launch of new products. On the other hand, the different approaches of communicating also increases relationship conflicts within the team. However, Pesch *et al.* (2015) summarize: “Our results indicate that the beneficial effects of communication style diversity outweigh the dysfunctional effects on innovation performance in teams. Age diversity however has only a positive association with relationship conflicts.” (p. 1). Söllner (2010) considers human capital diversity in context with innovations. The results of an empirical analysis indicate a positive relationship between the capacity to innovate and occupational diversity. Söllner (2010) sees the justification for this result in the fact that “[...] innovation is an interactive process, which requires the combination of diverse knowledge bases and different points of views [...]” (p. 22). According to that, Söllner (2010) states comparable results in terms of diversity categories such as heterogeneity of work experience. Tortoriello, McEvily and Krackhardt (2015) investigate the context between organizational innovation and knowledge diversity. In the frame of their analysis, knowledge diversity is defined as “[...] social structural conditions conducive to individuals supporting, facilitating, and promoting the innovativeness of their colleagues—a role we refer to as catalysts of innovation.” (p. 423). This perspective is based on the assumption, that an individual’s network position as well as the type of knowledge that is made available through networking are key enabling factors for innovation processes (Tortoriello *et al.*, 2015). In the frame of their study, knowledge diversity comprises external knowledge as a critical factor in innovation processes (Cohen and Levinthal, 1990; Chesbrough, 2003). Their results show, that direct benefits can be measured if employees have “[...] contacts that source diverse types of knowledge from outside the organization.” (p. 432). Conversely, this means that in the context of the concept of diversity categories (Gardenswartz and Rowe, 1991) various realities of life and backgrounds are advantageous to create a heterogenic information basis. Van Beers and Zand (2013) investigate in the frame of their study with 12811 innovating enterprises the impact of functional diversity and graphical diversity. In their approach, functional diversity is defined as “[...] cooperation with partners from multiple categories [...]” (p. 308), and graphical diversity as “[...] collaboration with partners in different countries.” (p. 308). Within the framework of their analysis, they differentiate between incremental and radical innovations. Their results show, that collaboration with external partners increases the performance of innovation activities. Differentiating radical and incremental innovations, there is a stronger effect in the context with radical innovations. Concerning the diversity of partners from diverse functional groups, Van Beers and Zand (2013) state, that there is a positive effect in the context with bringing radically new products to consumer market.

Looking at these results, different conclusions can be drawn. Science has tried to measure the relationship between diversity in the workforce and innovation by means of a wide variety of diversity categories (see figure 1). To achieve this, different approaches have been used. Most frequently, a quantitative approach is chosen. This approach is used to measure a correlation between defined indicators of diversity and an innovation output. The approach must always

be reflected when interpreting the results. Although a quantitative approach allows an overview of larger amounts of data, it makes it more difficult to analyze underlying or hidden structures and motives in more detail.

In summary, the analyses suggest two key findings. Following Gardenswartz and Rowe's (2003) diversity category system (see figure 1), different categories of diversity seem to have a positive effect on the development of innovations.



**Figure 1:** Classification of the mentioned studies in “The four layers of diversity” (Gardenswartz & Rowe, 2003)

\*Internal Dimensions and External Dimensions are adapted from Marilyn Loden and Judy Rosener, (1991)

However, the results also indicate that diversity creates challenges that need to be reflected. In particular, the complexity of interpersonal processes through the heterogeneity of perspectives and approaches must be considered. Thus, what on the one hand represents the potential of diversity in the innovation process seems also to be the huge challenge. This challenging aspect of a diverse workforce leads to a resulting need for an active diversity management (Bartz *et al.*, 1990; Aretz and Hansen, 2003; Nooteboom *et al.*, 2007; Hagenhoff, 2008; Günther, 2014; Lorenzo *et al.*, 2017).

As a result, successful diversity management fulfils two functions. On the one hand, it serves to create structures that enable the establishment of a diverse workforce. In the context of a diversity management approach, Lorenzo *et al.* (2017) state that there is a need for a critical mass of diverse people for achieving positive effects. Reflecting the study results in connection with Kanter's 'Tokenism', it illustrates that a clearer representation of diverse groups in terms of diversity categories (see figure 1) is required than previously assumed. While Kanter (1977) states in the context of assimilation strategies, that minorities up to a share of 15% are not perceived individually but as representatives of their group, a larger share seems to be required for the successful exploitation of various life realities, backgrounds and mindsets in the context of innovation and development processes. According to that, Lorenzo *et al.* (2017) conclude in the frame of their quantitative survey study “[o]nly when women occupy management positions does the innovation premium become evident. And it can't be a small number of women; innovation revenues only start to click in when at least

20% of managers at a company are female, our survey shows.” (p. 11). Zedlacher and Haar (2011) argue, that a higher share is necessary, to avoid group effects that hinder cooperation. From their point of view, dominant groups try to increase the difference to the minority. That often leads to social isolation of the tokens. On the other side, minorities try to develop coping strategies to compensate the difference to the majority. However, both group mechanisms lead to communication processes being blocked and cooperation being hampered (Zedlacher and Haar, 2011).

Therefore, the aim of a diversity management approach must be to establish organizational processes that support the active recruitment of a diverse workforce. This also goes hand in hand with the establishment of an overarching management strategy and an associated corporate culture, which advocates the establishment of these processes.

On the other hand, successful diversity management continues this recruitment process by creating a corporate culture that enables the potential of diversity to be harnessed. Østergaard *et al.* (2011) point out that in the frame of their study “[...] the logistic regression reveals a positive relationship between an open culture towards diversity and innovative performance.” (p. 1). The corporate culture represents the value pattern of an organization (O’Reilly and Chatman, 1996). Based on that framework, the range of possible individuality under the differentiated aspects of personality, professional competence, cultural, social, organizational and private environment etc. (see figure 1), is appreciated and supported. In this context, diversity thus describes both a state and a process. As a result, diversity management needs to be applied across all departments and affects all management processes of a company that create the framework conditions for cooperation within the company. It must be considered as an ongoing cross-functional process that encompasses all departments within an organization. Cox (1993) defines under the managing diversity approach “[...] planning and implementing organizational systems and practices to manage people so that the potential advantages of diversity are maximized while its potential disadvantages are minimized. The goal of managing diversity as maximizing the ability of all employees to contribute to organizational goals and to achieve their full potential unhindered by group identities such as gender, race, nationality, age, and departmental affiliation.” (p. 11). With regard to personnel management for example, this means to create an environment where employees can develop skills to achieve their maximum performance (Aretz and Hansen, 2003).

The more complex the company in terms of organizational structure, authority to issue directives and hierarchies, the greater the need for structured diversity management seems to be. Lorenzo *et al.* (2017) state that the positive effects of a diversity management approach can be seen especially in complex and large organizations. In particular, organizations that are homogeneous, mono-cultural and in which a dominant group determines the values, norms and rules for all employees and fills the relevant decision-making positions, face a major challenge (Vedder, 2001). This results in the need to deal in detail with the nature of the organization and to fathom the internal structures and processes. The active integration of employees into this analysis process is an important participative element, which enables a sustainable implementation of measures within the framework of diversity management. In this context, Aretz and Hansen (2003) proclaim a system theoretical approach. Based on the ‘theory of general systems of action’, the system theoretical approach serves as an analytical framework for capturing differentiated diversity dimensions, allowing the integration of previous diversity approaches (such as the Fairness & Discrimination Approach, Access & Legitimacy Approach and the Learning & Effectiveness Approach) and the development of multidimensional measures for diversity management (Aretz and Hansen, 2003). Basing on

that, the active management of diversity becomes a strategic approach of corporate management that addresses many challenges and their consequences at the employee level. In the frame of their approach, Aretz and Hansen (2003) state several assumptions:

- Perception, thinking and evaluation of individuals are shaped by social collective standards.
- The definitions and attributions of meaning are not made actively by individuals, but result from social interaction contexts. In this frame, they must acquire a certain social commitment in the sense of an institutionalization in order to be effective in society and/or organizations.
- Factual differences between people do not necessarily have to be socially perceived (in the sense of societal or organizational) and relevant. They can be perceived and defined differently.
- Differences between people can be socially constructed and thus become socially/organizational reality.
- It is important to consider that, in addition to communication-oriented aspect of acting, power-oriented action is also involved, in which the different benefit and power interests of the involved actors manifest themselves.

Reflecting the assumptions mentioned it becomes clear that diversity management does not have to be applied exclusively where visible diversity exists (Sepheri and Wagner, 2000; Voigt and Wagner, 2006). Within the framework of diversity management, it is also important to determine why an organization may not be diverse (Aretz and Hansen, 2003).

## **2. Diversity and change management**

Considering the accelerated economic dynamics with their growing pressure for change and innovation on companies and the necessity of a more efficient and effective use of the resource "human capital", Balsler (1999) mentions that especially mono-cultural organizations appear to be too rigid and oriented towards the past, too little capable of learning and adapting, as well as too little creative and innovative. Since the implementation of diversity management is accompanied by constant change and companies are subject to change due to external factors, there is a need to reflect on possible influencing factors that hinder the sustainable implementation of diversity management (Leicht-Scholten *et al.*, 2011). In Germany for example, the term 'feminism' has a negative connotation (Nagl-Docekal, 2012). With regard to diversity management, Studt (2016) states that barriers and resistance must be overcome, especially in qualitative management topics such as 'diversity'. Studt (2016) justifies this with the uncertainty with regard to the personal consequences of diversity management and the associated fear of loss of status, security, autonomy and recognition. Taking measurable indicators for the degree of diversity acceptance into account, the Workplace Gender Equality Agency (WGEA), an Australian Government statutory agency, measured and compared the gender pay gap across OECD countries (WGEA, 2018). The gender pay gap gives an overview over the differences in pay between women and men. This measurable indicator is an expression for status of equality in a country, because of its long-term impact of an individual's life. The WGEA (2018) argues that "[o]ver a lifetime, the cumulative effect of the gender pay gap and other factors, such as time spent out of the workforce and unconscious bias, contribute to women retiring with far less superannuation

savings and a higher risk of living in poverty in retirement than men. Addressing inequalities in the workplace is not only important in terms of justice, but because gender equality is central to a country's overall economic performance, and has been linked to improved national productivity, innovation and economic growth." (WGEA, 2018). Following the report, Germany has still one of the highest average gross hourly gender pay gross in Europe. Although, there are laws and measures that strive for a change of structural factors, there seems to be a reactance with regard to a change.

When implementing diversity management, especially in Germany there seems to be the need for reflecting different influencing factors. In the context with diversity categories and the perception of minorities, in particular socio-cultural factors and in this connection structural factors, but also historical and medial factors must be considered, for understanding the prevailing mindsets but also requirements, possible barriers and anxieties (Steuer, 2015; Leicht-Scholten *et al.*, 2009). Taking into account Kotter's eight steps of change management (Kotter, 1995) the active engagement with the workforce in an organization is therefore essential. As far back as 1967 Greiner stated that up to a certain extent each company needs to overcome existing inertial forces and resistance during transformation (Greiner, 1967). In this context, Aretz and Hansen (2003) define, basing on Hansen and Dolff (2000) as well as Thomas (1996), four options in dealing with diversity:

- a) Ignorance (e.g. denial, exclusion)
- b) Oppression (assimilation, oppression, isolation)
- c) Acceptance (Tolerance)
- d) Active promotion (building relationships, mutual adaptation)

While Aretz and Hansen (2003) consider separate options in the context with change through diversity management, Kotter (1996) regards these options as a coherent psychological reaction to change within a change process. From his point of view, the workforce can be divided in two groups. On the one hand, there are individuals that discover the need for change, on the other hand, other parts of the organization seem to prefer the existing situation and see no need for change. With regard to the second group, which is passive in the frame of a change context, the change results in the fear of destroying the existing state of satisfaction. Consequently, the passive group reacts by ignoring the need for change and aggression in respect of the change initiative. In this context, Kotter (1996) reports that "[...] 50% of the companies [...] fail in this first phase." (p. 3). For this reason, it is necessary to demonstrate the need for change on all organizational levels. Even in the case of cognition, depression/suppression can initially occur, as old patterns and structures have to be abandoned and new standards have to be learned. The constant confrontation with the idea of change as well as the communication of necessity lead to an awareness being generated in the passive group. This is accompanied by the clear communication of a vision in order to be able to reflect on perspectives and the advantages of change. Only through this reflection process, it is possible for the passive group to accept the change process and to actively participate in measures. According to Kotter (1996), a sustainable implementation of change requires "[...] institutionalizing change in corporate culture." (p. 8). (Kotter, 1996)

Bringing together these findings it is evident that there is a need for the active integration of the workforce and the management level for achieving a successful implementation of diversity management. Particularly against the background of the close linkage of the system



theoretical diversity management approach (Aretz and Hansen, 2003), Kotters (1996) insights in the frame of change management processes and the need to transfer the approach into the corporate culture (Østergaard *et al.*, 2011), it is necessary to actively involve organizations employees in the whole process.

According to Aretz and Hansen (2003), the trigger for diversity management can be seen in the social definitions and concepts of ‘diversity’, which then form the symbolic frame of reference for corresponding actions and strategies and create a social reality. As a result, it is necessary to examine whether and how diversity is socially constructed and defined in organizations. Following Köhler-Braun (1999), diversity can, for example, be regarded as a strategic success factor, as part of leadership behavior, as a management problem or as the result of legitimate action. In the frame of the investigation, the intentions and functions of diversity management then becomes clear. (Aretz and Hansen, 2003)

### **3. Research approach: Discovering prevailing mindsets of an organization’s workforce**

Especially with regard to the reflection of the need for change, it is essential to uncover reactance and to discover existing thought patterns. Following this current state of prevailing mindsets, it is then possible to develop an approach that takes up the different thought patterns. In the frame of the following study, we focus on thought patterns and mindsets in the context with gender and cultural diversity. In particular, the perception of diversity in general as well as the perception of the context between diversity and innovation against the background of the measured actual state of diversity within the framework of the organization will be examined. The study represents the third step of the research design (Steuer *et al.*, 2017). After analyzing the demographic status quo, management level was surveyed for identifying prevailing mindsets with regard to diversity and innovation. In the frame of this second study, six management types could be defined (Steuer and Leicht-Scholten, 2017). In the frame of this paper, the quantitative survey of the organizations workforce is presented. The focus is on the results in the context of gender and origin diversity.

#### **3.1 Gender diversity**

In the frame of their research, Díaz-García *et al.* (2013) come to the conclusion that gender diversity stands in a significant positive relationship with the development of radical innovations. Considering incremental innovations, there seems to be no significant effect (Díaz-García *et al.*, 2013). Nevertheless, Busolt and Kugele (2009) state that against the background of “[...] the economic dimension of sustainable development relies on innovation, the under-representation of women in science and technology in the European Union is of special concern.” (p. 109). Furthermore, they conclude that “[...] a productivity loss for the economy is to be expected.” (p. 109).

Although factual reasons stand for the increase of gender diversity, inner personal attitudes such as prejudices or the anticipation of disadvantages through diversity can stand in the way of the change of a corporate culture and thus the implementation of a diversity management approach. Gender diversity has to be considered especially against the background of an engineering-scientific and therefore often male-dominated environment. For this reason, it is necessary to deal with employees’ perception of gender diversity and to reflect the mindsets against the background of given organizational structures, influencing aspects and prevailing habits (Bourdieu, 1982).

#### **3.2 Cultural diversity**

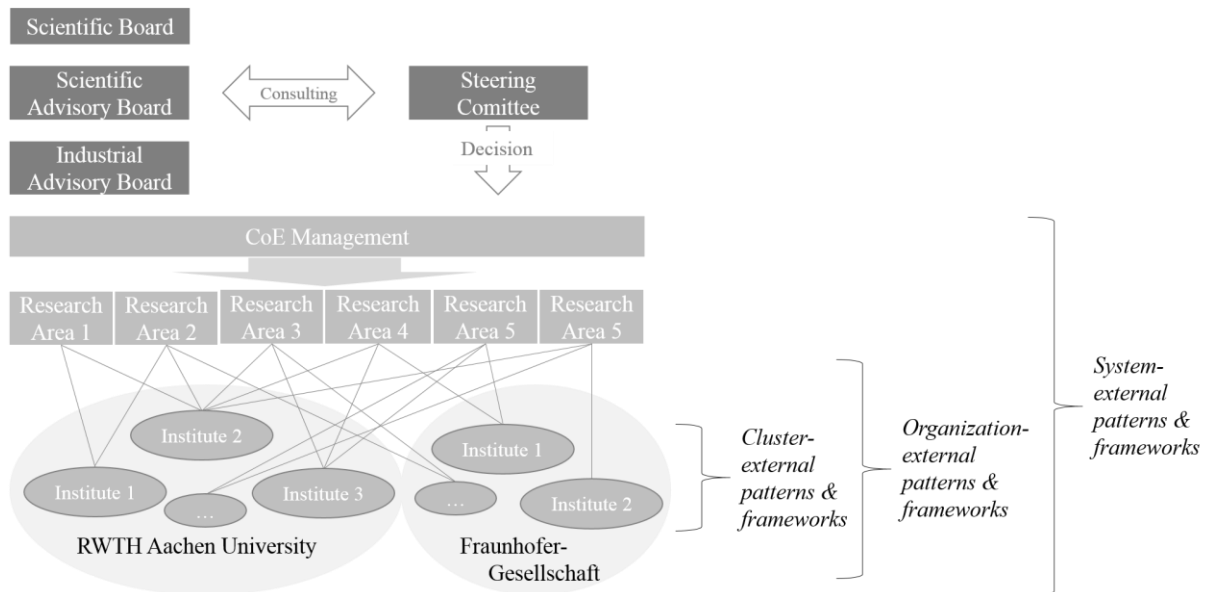
In the frame of a meta analysis the Bertelsmann Stiftung (2018) comes to the conclusion that there is a moderate positive link between cultural diversity and innovation. Bouncken, Brem and Kraus (2016) derive from their longitudinal qualitative study that cross-cultural teams have a high creative potential on the one hand, but are also confronted with difficulties due to different work and communication styles on the other hand. Gagliardi (2015) as well as Fassio, Montobbio and Venturini (2015) focus in the frame of their analysis on the context between migrant workers and innovation. They come to the conclusion that there is a positive connection between immigration and innovation. According to that, Parrotta, Pozzoli and Pytlikova (2012) state on the basis of their empirical analysis: “We find that an increase in firm labor diversity in terms of ethnicity has a positive effect on the firm innovation process.” (p. 26).

Different studies conclude that cultural diversity has a positive influence on different innovation contexts. However, with respect to the implementation of a diversity management approach, it is questionable to what extent there is awareness of the positive relationship between cultural diversity and innovation.

#### **4. Methodology**

In the frame of the analysis, descriptive as well as multivariate analyses were conducted. The study was carried out in the frame of a so called “Cluster of Excellence” (CoE) named “Integrative Production Technology for High-Wage Countries”. Connected to the university, the CoE represents organizations that bring scientists from different disciplines, departments and research groups together (see figure 2). In order to be able to understand the development of opinions and the influence of external factors on perception, it is necessary to fathom the organizational structure as well as the structural integration of CoEs.

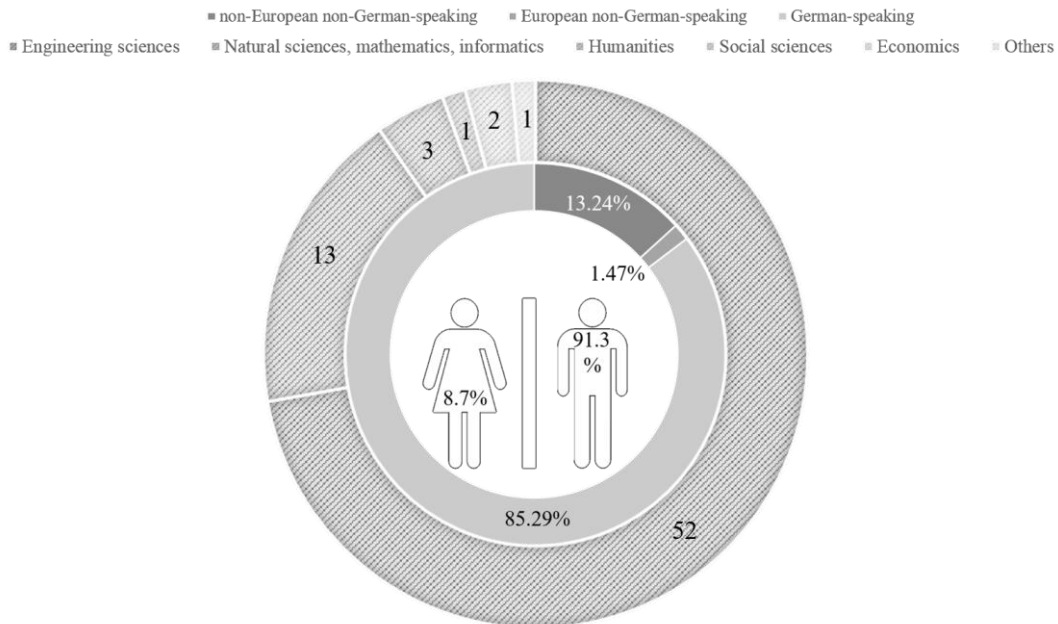
Steuer *et al.* (2017) capture the particularities of a CoE in the frame of a tripartite model. In the frame of this model, they differentiate between Cluster-external patterns and frameworks, Organization-external patterns and frameworks and System-external patterns and frameworks (see figure 2). All three layers describe influencing factors, which have an impact on the personnel structure but also prevailing attitudes and mindsets of the Cluster workforce. In this context, ‘Cluster-external patterns and frameworks’ refer to the employees working environment in the institutes. Within the framework of these research groups, employees are involved in institute-specific processes and work under a specific management style that may differ from that of other research groups. Furthermore, in the frame of this layer, factors like recruiting processes, dominant corporate culture, human resource management, as well as hierarchical factors are reflected. The layer ‘Organization-external patterns and frameworks’ summarizes the influencing factors given through university framework and faculty/department structures. Under ‘System-external patterns and frameworks’ Steuer *et al.* (2017) summarize factors affecting personnel law, contractual framework conditions, resulting fluctuation, expectations of the employer and loyalty to the organization.



**Figure 2:** Organizational Structure of the CoE "Integrative Production Technology for High-Wage Countries" (own figure)

The CoE staff consists of professors, junior professors, scientific staff and administrative personnel. With regard to the demographic data, 86.4% of all employees working in the Cluster are male. Due to the thematic focus of the CoE, 82.4% are related to institutes at the faculty of mechanical engineering, 11.8% are located at the faculty of natural sciences and mathematics, and whereas only 3.4% are affiliated within economics and 1.3% from linguistic and cultural sciences (1.1% gave no indication concerning the professional allocation). Considering the cultural background, 9.7% of Cluster employees have a non-German-background. Considering the demographic data and the top down organized management structure, the object of research can be classified as a scientific organization that has the characteristics mentioned by Vedder (2001) earlier. With regard to the subject culture, a dominant habitus can be identified, which can be explained by the thematic location of the CoE in mechanical engineering topics.

In the context of the presented quantitative study, the scientific staff (doctoral candidates and post-docs) were interviewed. With a share of 81.9% they represent the largest status group in the frame of the CoE "Integrative Production Technology for High-Wage Countries". A total of 149 persons from the status group were identified and invited to the survey by e-mail. 69 employees from the status group took part in the survey. Figure 3 summarizes the demographic data of the participants. With regard to the diversity category 'gender', 8.7% claimed to be female and 91.3% to be male. The average age of the interviewees was 32.58 years, with a minimum age of 26 years and a maximum age of 64 years. Considering the origin of the participants, 13.24% indicated to come from a non-European non-German-speaking country, 1.47% to come from a European non-German-speaking country and 85.29% to come from a German speaking country. Multiple answers were possible with regard to the specialist background. Thus, 52 times the affiliation to the engineering sciences, 13 times the natural sciences/ mathematics/ informatics 3 times an affiliation to the humanities, one time the affiliation to the social sciences, 2 times the economic sciences and one time others were given. If one considers the educational background with regard to the educational institution, 76.81% of the respondents completed their studies at the RWTH Aachen University and 23.19% at another university.



**Figure 3:** Demographic data of the CoE "Integrative Production Technology for High-Wage Countries" (own figure)

Summarizing the descriptive data of the CoE structure, one can assume that the CoE workforce is not diverse at the research assistant level.

The survey was conducted using a six-tiered Likert scale. The Likert scale was selected because it is suitable for measuring attitudes. In this context 'attitude' is the emotional, mental and action disposition towards an environmental aspect (Albers *et al.*, 2009). The setting is measured using several statements (items) which are evaluated by the test persons in a continuum from extremely positive to extremely negative (Stier, 2013). As a result, the items refer to a theoretical construct. This allows to summarize tendencies in the statements. Considered under measurement theory, Likert scale is ordinally scaled, resulting from the assumption that interviewees consider the intervals between the answers as equal (Völkl and Korb, 2017). In order to be able to use all statistical operations in data analysis, the Likert scale is often referred as quasi-metric and treated like an interval scale. A prerequisite for an interpretation as quasi-metric is that the variables have at least five expressions and that the distances between the answers can be interpreted semantically and by numerical value assignment as equal (Urban and Mayerl, 2011). Therefore, the response specifications are graded, but can be divided dichotomously by the six-step arrangement.

With regard to quantitative analysis, multiple response sets, Cramer's V and Kendall's Tau are used to examine perceptions of the diversity categories gender and culture in a context with innovation. With regard to the multiple answer set, dichotomies (consent and rejection) are formed for the questions of perception and attitude. These dichotomized variables can then be combined into a multiple answer set, whereby the agreement (= perceived diversity in a feature category) is recorded as a counted value. The advantage of this method is the direct comparison of the individual answer options with each other. The Cramer's V calculation is based on the chi-square statistic (David and Sutton, 2004). Cramer's V can be applied to any table size (Warner, 2013).

It provides information about the strength of a correlation, comparable to determining the correlation of variables. For the determination of these two measures, however, a nominal

scaling of the variables is sufficient. With regard to measures of association for ordinally scaled data, linear and non-linear relationships can also occur and statements can be made about the direction of the influence. Furthermore, a rank correlation coefficient analysis is conducted. The rank correlation can be used to describe the extent to which two rankings systematically vary with each other. Instead of the interval-scaled measured values, the respective rankings of the ordinal-scaled data are used. If there is a perfect correlation in the same sense, it is to be expected that the second data series will be arranged perfectly, i.e. (depending on the sorting selected) either from the smallest to the largest or from the largest to the smallest data set. In the case of a perfectly opposite relationship, on the other hand, it would be expected that the second data series would be sorted exactly opposite to the first data series. All other cases deviate more or less strongly from these two special cases. In the frame of the presented study, Kendall's Tau is applied due to its insensitivity to associated ranks. (Stephan, Turvey and Andreasen, 1999)

## 5. Results

In order to get an impression of the perception of the prevailing diversity, participants were asked about the perception of individual categories of diversity. As figure 2 shows, employees are influenced by their institutes as the institutes represent the daily working-environment. Furthermore, the institutes are the recruitment base for the research assistants that are part of the CoE workforce. Although the CoE represents an organizational framework, it can be seen as a functional construct under whose structure work is carried out decentrally in project groups. With regard to the reflection of diversity in the daily working environment, institutes and the CoE are therefore considered as separate organizations. With regard to the perception of diversity, it is assumed that the perception of diversity in everyday working life cannot be differentiated and reflected within the framework of the different organizational units (CoE and institutes). It is anticipated, that the influence of the daily working environment is stronger in terms of the perception of diversity.

### 5.1 Analysis based on multiple response sets

In order to standardize the answer to the question about the perception of diversity, a selection of diversity categories was made available within the framework of the survey. In the frame of the question 'Within my research institution the employees differ in terms of...'

- Age
- Professional background
- Marital status
- Gender
- Professional experience
- Physical abilities
- Origin
- Religion
- Way of working
- Native language
- Culture,

participants could choose between the diversity categories mentioned. The intention is that the participants reflect on diversity beyond naming frequently discussed categories such as 'gender' or categories perceived through individual intersectionality. In the frame of the survey, several answers were possible.

Analysis shows that 86.4% perceive diversity in terms of 'way of working', 79.9% 'marital status' and 69.5% 'professional background' and 62.7% 'gender' diversity. Considering the perception of individual diversity categories divided according to 'gender', it becomes clear that there is a similar perception with regard to the diversity categories 'way of working' (83.3% females/ 86.8% males) and 'professional background' (66.7% females/ 69.8% males). Major differences exist in the perception of the categories 'professional experience' (33.33% females/ 69.8% males), 'physical abilities' (16.7% females/ 52.8% males) and 'marital status' (50% females/ 83% males). Differentiating the perception of individual categories with regard to 'origin', it becomes clear that, comparable with the results divided according to 'gender', 'way of working' (86.3% German-speaking region/ 85.7% non-German-speaking region) and 'professional background' (68.6% German-speaking region/ 71.4% non-German-speaking region) are the most frequently perceived diversity categories seen among employees from the German-speaking region as well as among employees from the non-German-speaking region. The largest difference in perception within this group can be found in the categories of 'physical abilities' (41.2% German-speaking region/ 100% non-German-speaking region), 'age' (51% German-speaking region/ 85.7% non-German-speaking region) and 'origin' (58.8% German-speaking region/ 85.7% non-German-speaking region).

## **5.2 Analysis based on Cramer's V**

Following the perception of specific diversity categories within the institutes, the respondents were asked about the perceived relationship between individual diversity categories and innovation. With regard to the relationship between 'origin' and 'different mother tongues increase innovative capacity', a Cramer's V of .573, of a possible maximum value of 1, shows a medium association with a very significant value ( $p < .01$ ). Considered separately, analysis shows while employees from non-German-speaking countries (100%) see a connection between the diversity of native languages and the ability to innovate, the absolute majority of employees from German-speaking countries reject (82%) a positive connection between diverse native languages and the ability to innovate. Considering the perception of the diverse gender, male (83%) as well as female (83.3%) test subjects dominantly agree that there is a perceived positive connection between gender-mixed team constellations and innovative ability. With regard to the relationship between the diversity category 'gender' and the increase in innovation capacity through gender-mixed constellations, only a negligibly small relationship can be identified between 'gender' and 'gender-mixed constellations increase innovative capacity'. A Cramer's V of .003 and a corresponding error probability of almost 99% suggests that there is no correlation between the perception of a positive impact of gender-mixed teams of men and women.

**Table 1:** Chi-square and Cramer's V for the diversity categories gender and origin

	“gender-mixed team constellations promote cooperation”	“gender-mixed team constellations increase innovative capacity”	“different mother tongues promote cooperation”	“different mother tongues increase innovative capacity”	Index
Gender	.000 -.003 .003	.000 -.003 .003			Chi-square Phi Cramer's V
Origin			16.382 .531** .531**	18.368 .573** .573**	Chi-square Phi Cramer's V

\*\*p<.01

In addition, the participants were asked to what extent individual diversity categories promote cooperation. Analysis shows, that there is a moderate correlation between ‘origin’ and ‘different mother tongues promote cooperation’ (Cramer's V = .531) with a very significant value ( $p < .01$ ). Looking at the individual groups, test persons from non-German-speaking countries tend to agree (71.4%), while those from German-speaking countries dominantly reject (90.2%) a positive context between different mother tongues and cooperation. Considering According to that, female (83.3%) as well as male (83%) employees dominantly state, that gender-mixed constellations promote cooperation. A Cramer's V of .003 and a corresponding error probability of almost 99% suggests that there is no correlation between the perception of a positive impact of gender-mixed teams with regard to the promotion of cooperation and gender.

### 5.3 Analysis based on Kendall's Tau

In the frame of the survey, participants are asked whether they consider the status of diversity as too high, ‘sufficient’ or ‘too low’. Both the significance of diversity within the institutes as well as the significance within the CoE and thus the overarching organization are elicited separately. In a next step, the extent to which diversity characteristics perceived as particularly present (see 4.1 multiple response sets) provide information about the perception of the importance of diversity in the frame of the institute, was investigated. In a first step, the significance of the institute as a daily working environment for the participants is examined. As table 2 shows, there is no significant correlation between the perception of certain diversity characteristics and the perception of a ‘sufficient’ status of diversity at the institute. On the contrary, several significant correlations with the perception of a ‘too high’ value of diversity could be found (religion: .268, culture: .262 mother tongue: .247 and origin: .240). These correlations are all positive. This means that the more diverse the institute is perceived in terms of religion, culture, mother tongue and origin the more the value of diversity at the institute is perceived as ‘too high’. It is interesting to note that the topic of ‘gender’, communicated most strongly at RWTH Aachen University, does not show any significant correlation (.123) with regard to a ‘too high’ importance. The values tend to be significant ( $p < .05$ ). With regard to a perception of a ‘too low’ value, only a significant negative correlation with the category of ‘professional background’ (-0.230) could be found. Conversely, this means the more diverse the institute is perceived with regard to its professional background, the less likely it is that the importance of diversity will be perceived as ‘too low’ at the institute.

**Table 2:** Kendall's tau-b perception of diversity and importance of diversity in the institution

Perception of Diversity Category	"in my institution the importance of diversity is sufficient"	"in my institution the importance of diversity is too high"	"in my institution the importance of diversity is too low"	Index
Gender	.114	.123	-.149	Kendalls tau-b
Origin	.140	.240*	-.085	Kendalls tau-b
Mother Tongue	.041	.247*	-.109	Kendalls tau-b
Culture	.009	.262*	-.030	Kendalls tau-b
Religion	.169	.268*	-.213	Kendalls tau-b

\*p<.05

In order to investigate whether the organizations of the institutes are regarded by the employees separately from the CoE as a superordinate organization, it is necessary to analyze the value of diversity in the institutes as well as its significance in the frame of the CoE. Comparable to the results in the context of the perception of a 'sufficient' importance of diversity in the institutes (table 2), no significant correlation can be determined with regard to the perception of a 'sufficient' importance of diversity in the CoE. However, as table 3 shows, similar results can also be observed for a 'too high' and 'too low' status of diversity in the frame of the CoE.

**Table 3:** Kendall's tau-b perception of diversity and importance of diversity in the CoE

Perception of Diversity Category	"in the CoE the importance of diversity is sufficient"	"in the CoE the importance of diversity is too high"	"in the CoE the importance of diversity is too low"	Index
Gender	-.108	-.015	.197	Kendalls tau-b
Origin	-.001	.143	.060	Kendalls tau-b
Mother Tongue	-.066	-.016	-.060	Kendalls tau-b
Culture	-.021	.069	.033	Kendalls tau-b
Religion	-.030	.129	-.019	Kendalls tau-b

Table 4 provides information on the extent to which the perception of the importance of diversity in one's own institute differs from the perception of the importance of diversity in the frame of the CoE. As figure 2 shows, it is particularly important to compare perceptions within the framework of the two forms of organization in order to draw conclusions about



suitable measures. The analysis makes it possible to link the functional structure of the CoE as a superordinate organization with the institutes as organizations representing the daily working environment.

Considering the perceived importance of diversity, the results indicate that the employees do not differentiate between the CoE and the respective institute. A Kendall's tau of .296 ('sufficient' importance of diversity) and .298 ('too low' importance of diversity) indicates a weakly positive correlation. Furthermore, if diversity is consciously perceived with regard to some categories, it cannot be assumed, however, that the significance of diversity is perceived as 'sufficient'.

**Table 4: Diversities status in the CoE and the institutes**

	"in the CoE the importance of diversity is sufficient"	"in the CoE the importance of diversity is too high"	"in the CoE the importance of diversity is too low"	Index
"in my institution the importance of diversity is sufficient"	.296**			Kendalls tau-b
"in my institution the importance of diversity is too high"		.130		Kendalls tau-b
"in my institution the importance of diversity is too low"			.298*	Kendalls tau-b

\*p<.05; \*\*p<.01

## 6. Discussion and Limitations

It can be stated that the perception of diversity is different for both, visible diversity and for less visible diversity (see chapter 5.1). The perception certain diversity categories within the framework of the institutes is fundamentally different. Thus, the diversity categories 'way of working' and 'professional background' are perceived most often. Initially, this finding may also result from the fact that participants come from different institutes. In order to compare this result with the CoE, the connection between the statements made within the CoE and those made by the institutes are examined within the framework of Kendall's Tau (see chapter 5.3). In this context, it is interesting to note that there is no differentiation in the perception of diversity in the CoE and the institutes. Taking into account the great differences within the institutes also coming from different scientific disciplines and led with diverse leadership styles, the findings have to be validated by further research. Two explanations could be either the employees do not differentiate the functional organization of the CoE from the daily

working environment of the institute, or the investigated target group does not perceive any structural differences. In both cases, a qualitative approach is needed to further explore the extent to which perception is influenced by the environment.

Considering the results on the connection of individual diversity categories within the framework of innovations, different perceptions can be determined. While gender diversity is perceived as being related to innovation services, it is rejected in the context of origin (within the framework of different mother tongues). Different mother tongues thus seem to be perceived as a barrier. It is questionable whether this statement is based on experience or within the framework of an anticipated assumption based on stereotypes. Origin is in a close context with the cultural background. While the indication of origin represents an objective query, the questioning of the feeling of belonging or the location to a specific cultural background or environment represents a greater challenge. This becomes clear through the definition approaches of the concept of culture. Thomas (2005) defines culture as a man-made part of the environment, which, however, is manifested by creating a typical pattern of meaning or orientation for a nation, society, organization or group. National origin can, but does not have to, go hand in hand with a sense of cultural belonging. Thomas (2005) further defines that the orientation system is made up of specific symbols. As an example, he mentions 'language'. Culture and language are often viewed in a symbiosis. Why is this relevant in this context? In order to further investigate the delimitability of the diversity categories in the context of innovation, it is necessary to engage more closely with the employees with regard to their experiences with diversity and the individual definition of culture. In doing so, it is possible to draw conclusions about possible reactances in the implementation of diversity management. On the contrary, considering the category 'gender', it is not possible to draw conclusions about reactances, as both women and men see a relation between gender-mixed teams and innovation. Reasons for this attitude may lay in the normative commitment of the university as well as the faculties and the institutes referring to gender equality, so the answers could be driven by the intent being political correct. It is questionable whether the reactions carried out by Kotter (1995) in the context of a change management process can be observed during the actual implementation of measures. In the context of further research, it is therefore necessary to examine the question of the extent to which normative response behavior is involved.

A further insight into the consideration of diversity issues is provided by the question of the significance of diversity. The significance of diversity in the CoE as a superordinate institution is of particular importance. Although a connection is seen between the diversity category 'gender' and innovation (see Chapter 5.2), the significance of diversity is also rated as 'too high' (see Chapter 5.3). However, if one considers the measured gender diversity within the framework of the distribution of women and men in the CoE (see Figure 3), it becomes clear that the perception does not correspond to the current workforce structure. This may also be due to the fact that the survey was conducted in a strategic manner. In both cases, a strategic voting process that is intended to prevent the promotion of the topic as well as in case of true perception of a connection between gender and innovation and the simultaneous perception of a 'too high' value, a top-down strategy must be pursued, that communicates the need against the background of an empirically proven potential of diversity in innovation contexts. At the same time, it is important to question when an organization is perceived as sufficiently diverse. With regard to the correlation results, it should be considered that the correlation is an observation, but the observation does not allow any direct conclusion to be drawn about causality.

A limiting element is the high fluctuation within the CoE and the institutes. Although 149 target persons could be identified in this context, it is questionable which actual number of CoE member can be assumed. However, the study gives a valid overview over prevailing mindsets and attitudes and fluctuation is expected to have a minor influence.

In the frame of a next step, the different types of perception in the CoE workforce must be combined with the different types from the management level, in order to develop a strategy that reflects the different perceptions, needs and perspectives.

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